(12) UK Patent Application (19) GB (11) 2 241 850 (13) A

(43) Date of A publication 11.09.1991

(21) Application No 9005197.0

(22) Date of filing 08.03.1990

(71) Applicant
The Marconi Company Limited

(Incorporated in the United Kingdom)

The Grove, Warren Lane, Stanmore, Middlesex, HA7 4LY, United Kingdom

(72) Inventor
Barry Gordon West

(74) Agent and/or Address for Service
R.K. Tolfree
GEC Patent Department (Chelmsford Office), GEC-Marconi Research Centre, West Hanningfield Road, Great Baddow, Essex, CM2 8HN, United Kingdom

(51) INT CL[5]
H04Q 7/04

(52) UK CL (Edition K)
H4K KYR

(56) Documents cited
GB 2208774 A GB 2014827 A EP 0280543 A2
EP 0210811 A2

(58) Field of search
UK CL (Edition J) H4K KYA KYR, H4L LDPX LDSD, H4M MTX1 MTX2 MTX3
INT CL[4] H04J 3/00, H04Q 7/00 7/02
Online databases : WPI

# (54) Signal transmission system

(57) A communications link is established between first and third stations via an intermediate second station, using time multiplexing. Each transmission, from first to second, second to first, second to third, third to second, takes place in a different time slot so that receiver performance is not degraded by strong signals from local transmitters. As described the system comprises a vehicle mounted cellular radio telephone with a cordless portable handset which can be used away from the vehicle. The transmission frequencies also differ.

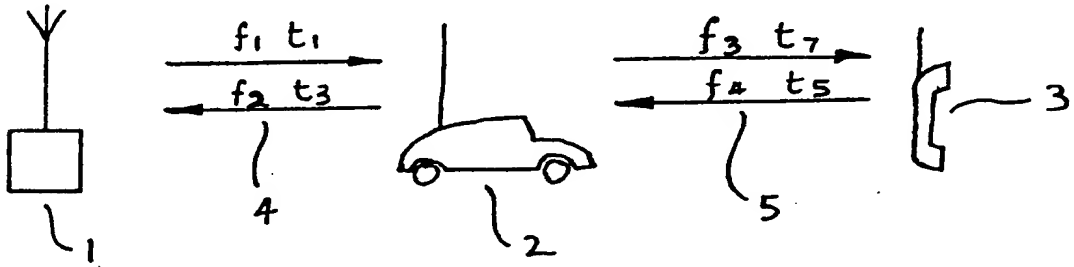


Fig 2

GB 2 241 850 A

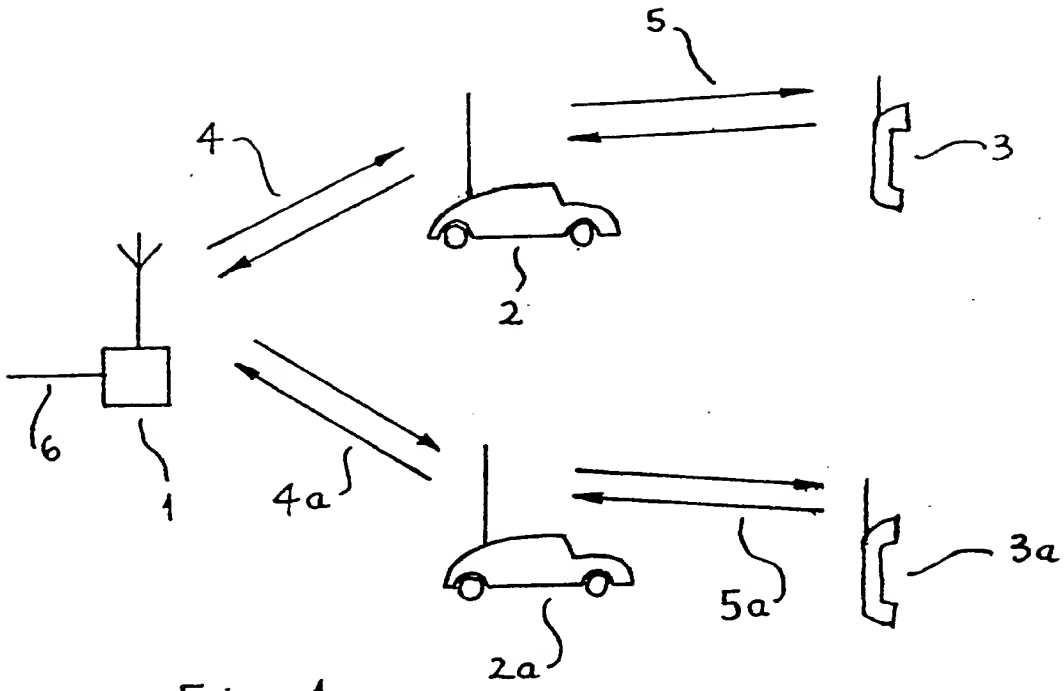


Fig 1

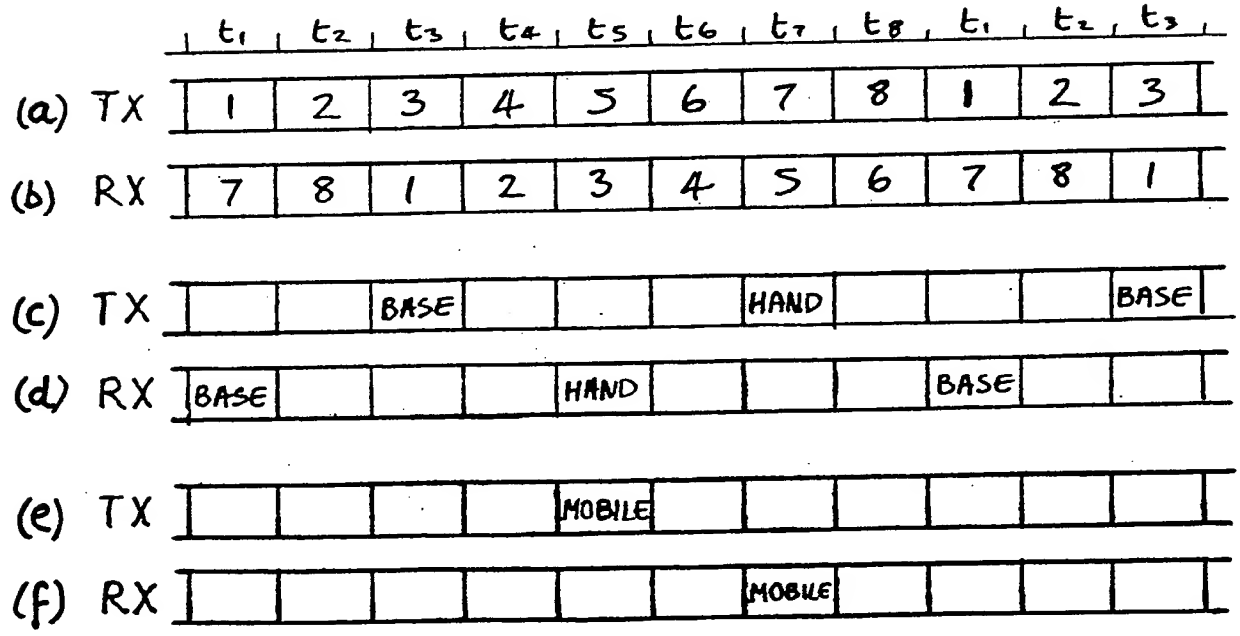


Fig 5

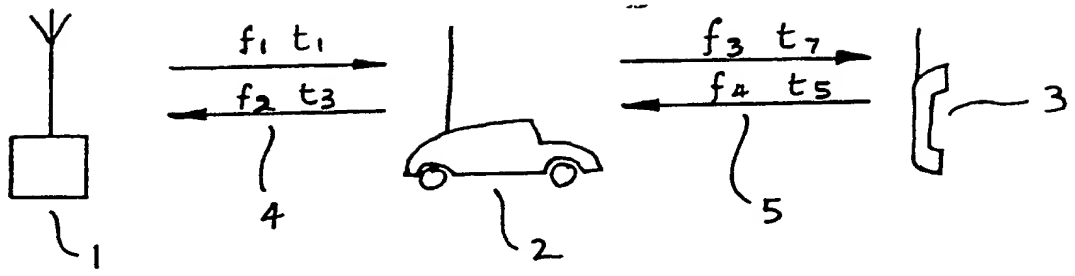


Fig 2

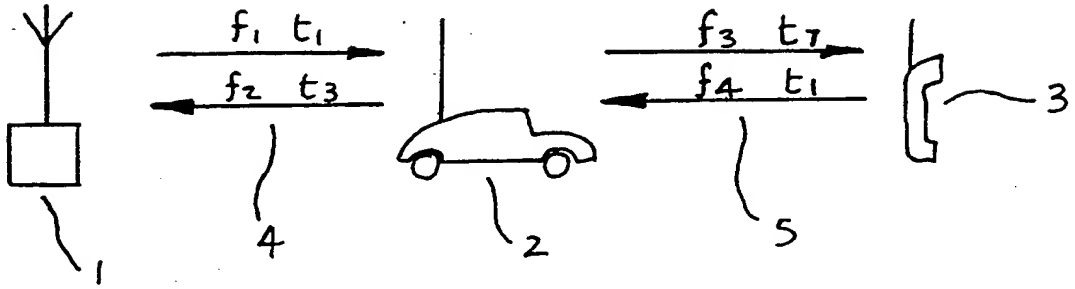


Fig 3

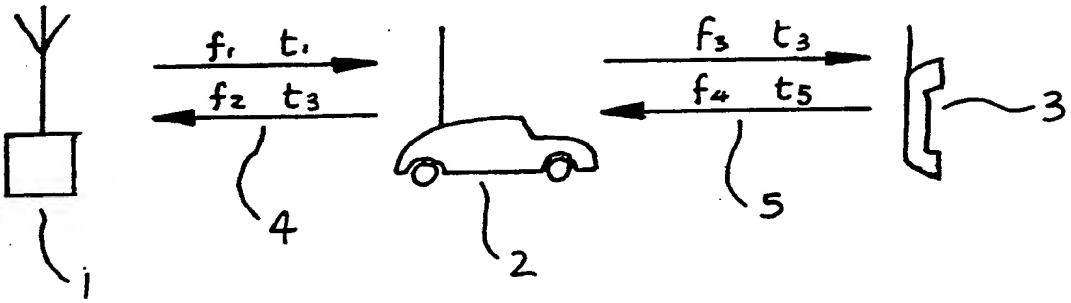


Fig 4

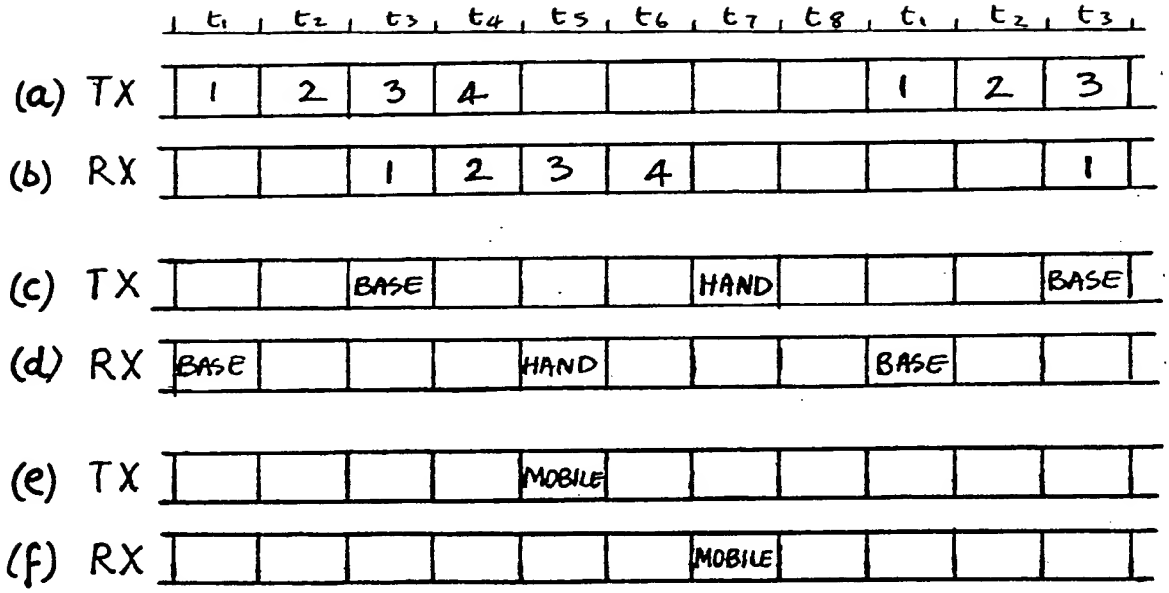


Fig 6

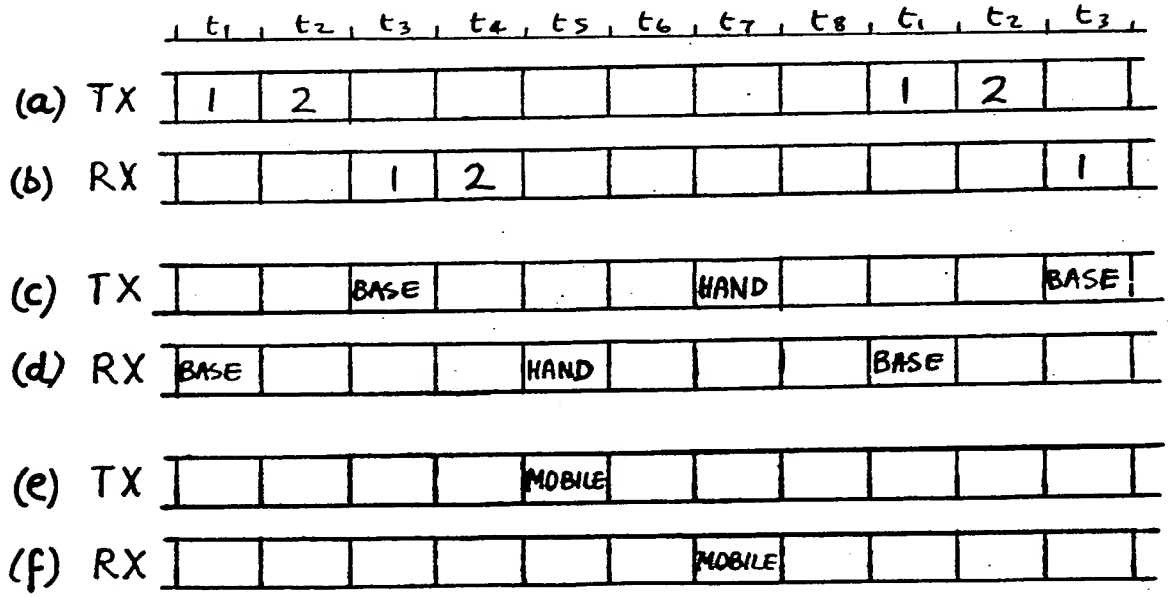


Fig 7

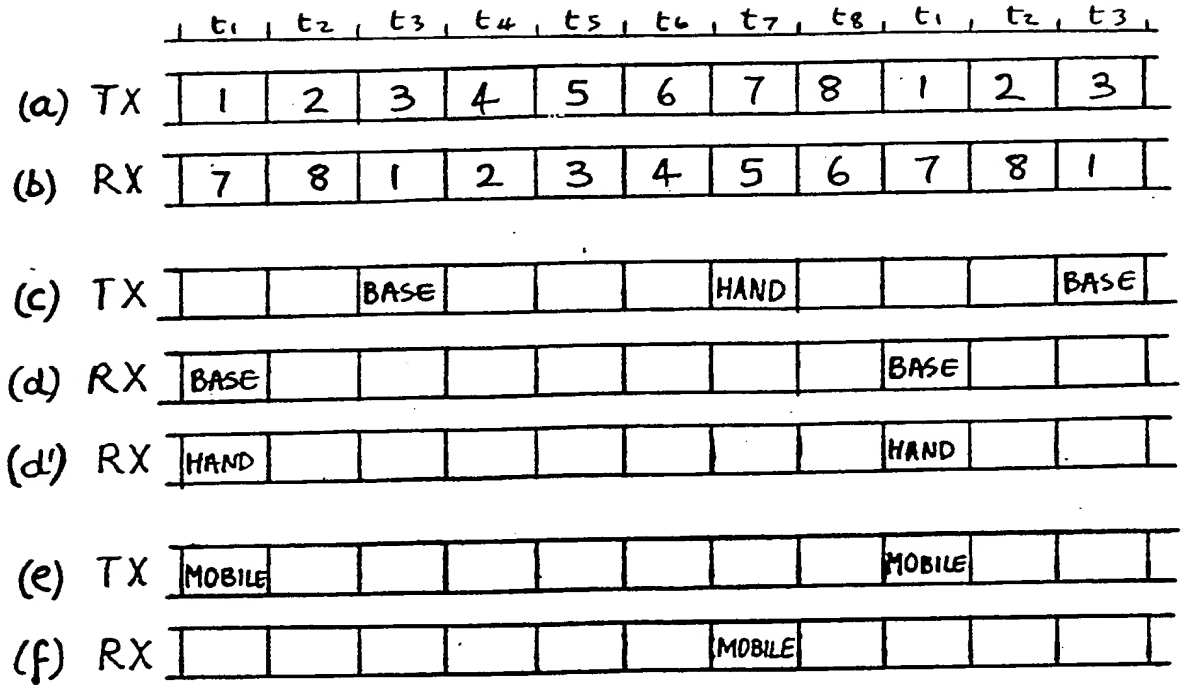


Fig 8

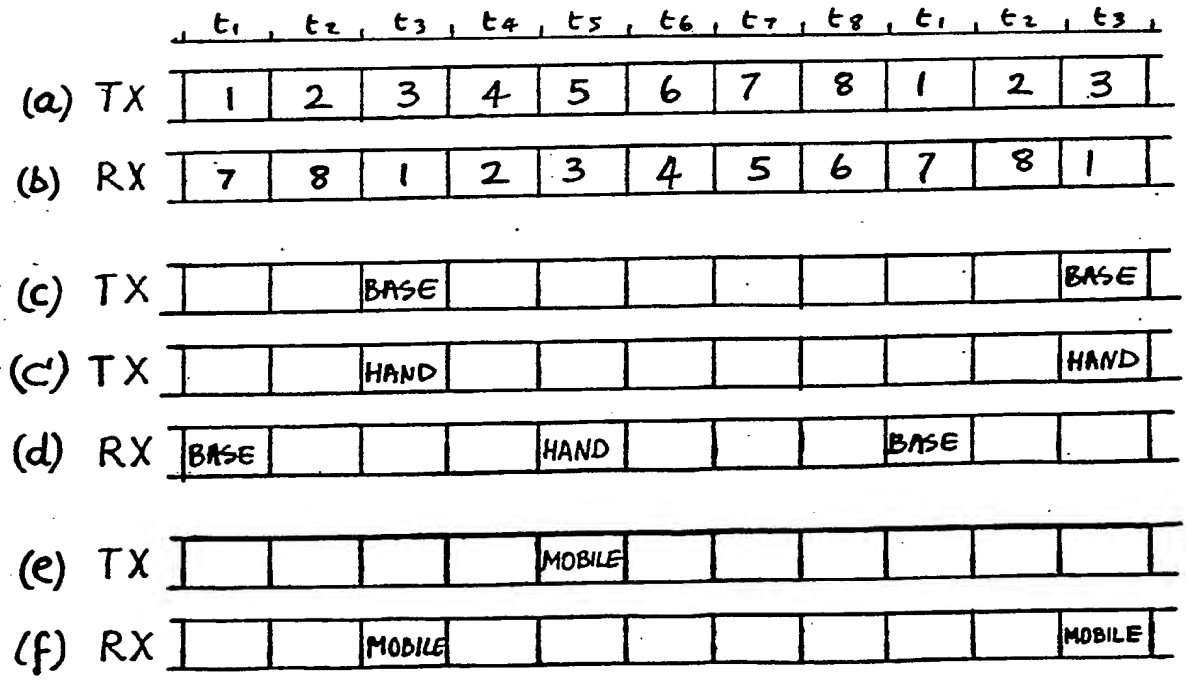


Fig 9

# Signal Transmission System

This invention relates to signal transmission systems, in particular systems in which a two way communications link is established by means of a time divided transmission system.

One known technique for providing substantially simultaneous two-way transmission between two stations is Time Division Duplex (TDD). In this technique, transmission in the two different directions takes place alternately, each station maintaining synchronism with the other to prevent clashing of the transmissions.

Another known technique is Time Division Multiple Access (TDMA). In this technique, time is divided into a number of frames. Each frame is sub-divided into a number of slots, and each of the N stations uses every Nth slot for its transmission or reception. This is applicable to signal transmission in one channel in one direction between one central station and each of a plurality N of others. If two-way communication is needed, a second channel is used for communication in the opposite direction.

Cellular radio systems utilise digital transmission and TDMA to multiplex several mobile users onto one channel. A first frequency is used for the uplink (mobile to base) and a second frequency, generally offset from the first by a predetermined amount, is used for the down link (base to mobile) directions of transmission. Unless the mobile's receiver be provided with high-performance front end filters, the presence of a strong signal from the mobile's transmitter will degrade receiver performance, even if the strong signal is some way away from the frequency to which the receiver is tuned. Such filters tend to be expensive. A cellular radio base station is generally provided with such filters as it has to simultaneously transmit on one frequency and receive on another frequency.

In a TDMA system, the necessity for such filters in mobile stations is avoided by ensuring that, for the mobile station, transmission takes place in a different time slot from reception. Thus the receiver never has to cope with the presence of a strong signal from its own transmitter.

In general, mobile stations comprise vehicle mounted equipment, and it would be useful to provide the users of such mobile stations with a cordless handset to allow the subscriber to communicate with the base station when he is absent from, but in the near vicinity of, his vehicle, the vehicle-mounted equipment acting as a relay station between the cordless handset and the base station. One way to implement this would be to provide the vehicle with an auxiliary transmitter and receiver operating on frequencies which were not otherwise being used in that particular cell of the cellular network. This would involve the extra expense of providing the mobile station with a second receiver and a second transmitter for the radio link to the handset. Also, reception could be degraded by the presence of a strong local transmission from the mobile for one radio link (e.g. mobile to base) at the same time as the mobile was receiving signals from the other link (handset to mobile), or vice versa.

By employing the invention it is possible to provide a signal transmission system which reduces the effect of these disadvantages.

In accordance with the invention a signal

transmission system comprising first, second and third stations in which a first two-way communications link is established between the first and second stations, from the first to the second station taking place in a first time slot of a time frame and transmission from the second to the first taking place in a second time slot of the time frame; in which a second two-way communications link is established between the second and third stations, transmission from the second to the third station taking place in a third time slot of the time frame and transmission from the third to the second taking place in a fourth time slot of the time frame; in which the first and fourth time slots do not overlap and/or the second and third timeslots do not overlap.

The first communication link may use a different transmission technique from the second communication link. The communications links may utilise broadcast or guided techniques, and may make use of radio transmissions or light.

The invention will now be described with reference to the accompanying drawings in which;

Figure 1 shows a signal transmission system

incorporating the invention;

Figure 2 shows a communications link utilising a first embodiment of a signal transmission system in accordance with the invention;

Figure 3 shows a communications link utilising a second embodiment of a signal transmission system in accordance with the invention;

Figure 4 shows a communications link utilising a third embodiment of a signal transmission system in accordance with the invention; and

Figures 5 to 9 show a timing diagrams illustrating the operation of signal transmission systems in accordance with the invention.

Figure 1 shows in diagrammatic form one cell of a cellular radio system. The cell is centred about a base station 1 which is linked to a telecommunications network by a link 6 and which provides respective two-way communication links 4, 4a between itself and a number of mobile subscribers 2, 2a located within the cell. The mobile subscribers 2, 2a have respective low

power cordless handsets 3, 3a by means of which a subscriber can communicate with the base station 1 using his respective mobile 2, 2a as a relay station via respective two-way radio links 5, 5a between cordless hand sets 3, 3a and their respective mobiles. Complete duplication of the transmitter and/or receiver equipment in the mobile stations is avoided by use of a signal transmission system in accordance with the invention.

A first embodiment of the invention will now be described with reference to Figures 2 and 5. In Figure 2, transmission between the base station 1 and the mobile station 2 and between the mobile station 2 and the handset 3 take place during mutually non-overlapping time slots t1, t3, t5, t7 using respective frequencies f1 to f4. This means that the mobile 2 requires only a single transmitter and a single receiver. Figure 5 shows a timing diagram of the transmission system used with Figure 2. As shown in Figure 5, time is divided into frames, each frame being subdivided into eight slots t1 to t8, the frames being continuously repeated. This allows communication with up to eight mobiles. In Figure 5, (a) and (b) respectively indicate the transmit and receive operations of the base station, the numbers 1 to 8 identifying the mobiles being transmitted to or

received during the respective time slots. The arrangement shown in Figure 2 represents mobile Number 1, and accordingly from 5 (a) and (b) it is seen that, for mobile Number 1, transmission from base to mobile takes place during time t1, and transmission from mobile to base during time t3. Figure 5 (c) and (d) indicate the transmit and receive operations of mobile Number 1. From (c) it is seen that the mobile transmitter transmits to the base during t3 and to the handset during t7. Likewise, from (d) the mobile receiver receives from the base during t1 and from the handset during t5. Figure 5 (e) and (f) indicate the transmit and receive operations of the handset 3. From 5 (e) it is seen that the handset transmits to the mobile during t5 and from 5 (f) it receives from mobile during t7. In addition to avoiding any duplication of equipment, receiver degradation due to the presence of a strong local transmitter is eliminated as the mobile station never transmits at the same time as it receives.

The link 4 between base and mobile may be a conventional TDMA transmission system in which the uplink and downlink frequencies f1 and f2 are different. The link 5 between mobile and base may use two further different frequencies f3 and f4 for its uplink and

downlink frequencies, the four frequencies f1 to f4 all being different. In the case of equipment having a microprocessor - controlled phase locked loop frequency synthesiser, this embodiment may be implemented relatively easily by reprogramming the microcomputer which controls the frequency synthesiser. In TDMA systems in which each frame is divided into eight or more time slots, it is advantageous, but not essential, to stagger the transmit and receive time slots as shown in Figure 5. This allows the maximum time between time slots for the frequency synthesiser to settle to its new frequency.

In a modification of Figure 2, the link 5 may use the same frequencies as link 4. In this case the number of mobile subscribers 2 connectable with the base station 1 would be reduced, as some of the available time slots normally occupied by links 4 to other mobiles or would instead be occupied by link 5, and thus in Figure 2, f1 = f3 and f2 = f4. The timing diagram of such an arrangement is shown in Figure 6, in which (a) to (f) have the same significance as (a) to (f) in Figure 5. Figure 6 shows the extreme case in which each mobile is using its own remote handset. Under these circumstances, this arrangement will allow only four

mobiles to be connected to the base station, as four of the eight available time slots have to be allocated to the links 5 between mobile and handset. However, the mobile equipment does not have to change frequency when switching between transmitting to base during t3 and transmitting to handset during t7, and similarly for reception. If not all mobiles have cordless handsets, or not all cordless handset are in use, then the reduction in capacity is not so severe. If necessary, the system can incorporate provision for informing the base station how many handsets are in use so that it can allocate time slots accordingly. For example, in a digital communications system, one or more bits of digital words transmitted to the base from the mobile could be set or unset according to whether a cordless handset was in use or not.

In a further modification of Figure 2 all frequencies f1 to f4 may be the same. This would further reduce the capacity of the system but would simplify the hardware. The timing diagram of such an arrangement is shown in Figure 7, in which (a) to (f) have the same significance as in Figure 5. Figure 7 shows the case when each mobile is using its handset. Under these circumstances, only two mobiles are

connectable to the base station. As for Figure 6, if not all mobiles were using their handsets, more mobiles could be connected to the base station.

A second embodiment of the invention will now be described with reference to Figures 3 and 8. In Figure 8,8 (a) to (c) and (e) and (f) have the same significance as in Figure 5, while (d) relates to the first receivers receiving base transmissions, on frequency f1, and 8 (d') relates to the receiver receiving handset transmissions on frequency f4.

Figure 3 differs from Figure 2 in that the mobile subscriber 2 has a single transmitter, but has a first receiver for receiving signals as a first frequency f1 form the base station 1 and a second receiver for receiving signals at a second frequency f4 from the handset 3. The reception periods overlap at least partially during time t1. Transmissions are effected at times t3 and t7 which do not overlap with each other or with the time t1 of reception. The transmission frequencies f2 and f3 may be the same or different according to the system requirements. Compared with the arrangement of Figure 2, this embodiment utilises an additional receiver, but does not require complete

duplication of the equipment.

Note that, while transmissions from the base and from the handset to the mobile are shown as extending over period t1 only, they need not be exactly coterminous. In accordance with the invention it is only necessary that at least part of the respective transmissions as received by the mobile station overlap in time. For example the transmitted signal shown in 8 (e) and the corresponding reception in 8 (d') as occurring during t1 could also extend into t2 and/or t8.

A third embodiment of the invention will now be described with reference to Figures 4 and 9. This embodiment differs from that of Figure 2 in that the mobile 2 of Figure 4 has a single receiver but has a first transmitter for transmitting signals to the base station 1 at a first frequency f2 and a second transmitter for transmitting signals to the handset 3 at a second frequency f3, both transmissions at least partially overlapping during time t3. The timing diagram for this arrangement is shown in Figure 9, in which (c) represents the timing of the first transmitter transmitting to the base station 1, and (c') represents the second transmitter transmitting to the handset 3.

The other parts of Figure 9 have the same significance as in Figure 5. Signals are received from the base station during time t1 and from the handset during time t5, which times do not overlap each other or the time t3 of transmission. The received frequencies f1 and f4 may be the same or different according to system requirements. While this arrangement requires the provision of an additional transmitter, it uses the same receiver of both link 4 and link 5, and thus does not require complete duplication of the equipment. Note that, as with the second embodiment, while transmissions to the base and to the handset are shown in Figure 9 as extending over period t3 only, they need not be exactly coterminous. In accordance with the invention it is only necessary that at least part of the respective transmissions be coterminous. For example the transmitted signal shown in 9 (c') and the corresponding reception in 9 (f) as occurring during t3 could also extend into t2 and/or t4.

The timing diagrams shown in Figures 5 to 9 are given by way of example only with a view to explaining the operation of the invention. The invention could equally will be performed with timing sequences other than those depicted, as is well known to those skilled

in the art.

In the embodiments just described, the first communication link 4 and the second communication link 5 may use different transmission techniques. For example, the first communications link 4 may comprise a digital cellular radio technique of the type known in the art as GSM, while the second communications link 5 may use a technique applicable to cordless telecommunication of the type known as DECT. Such techniques are known to those skilled in the art and are the subject of documents and standards submitted to and available from the European Telecommunications Standards Institute (ETSI).

While the invention has been described by way of example with reference to a cellular mobile radio system, the invention is not restricted to the particular embodiments shown, but may be used in a variety of different fields involving two-way communication. For example, the links between the various stations need not be radio frequency links but may comprise light, including visible light and infra-red or ultra violet light, or acoustic links, including supersonic and subsonic frequencies as well as

audio frequencies. The links themselves need not be effected by via radio transmissions, but may be via guided transmissions, such as transmissions lines, waveguides, or fibre optics.

CLAIMS

1. A signal transmission system comprising first, second and third stations in which a first two-way communication link is established between the first and second stations, transmission from the first to the second station taking place in a first time slot of a time frame and transmission from the second to the first taking place in a second time slot of the time frame; in which a second two-way communication link is established between the second and third stations, transmission from the second to the third station taking place in a third time slot of the time frame and transmission from the third to the second taking place in a fourth time slot of the time frame; in which the first and fourth time slots do not overlap and/or the second and third timeslots do not overlap.

2. A signal transmission system as claimed in claim 1 in which the first two-way communication link uses different frequencies for the two different directions of transmission.

3. A signal transmission system as claimed in claim 1 in which the first two-way communications link uses a single frequency for both directions of transmission.

4. A signal transmission system as claimed in any preceding claim in which the second two-way communications link uses different frequencies for the different directions of transmission.

5. A signal transmission system as claimed in any of claims 1 to 3 in which the second two-way communications link uses a single further frequency for both direction of transmission.

6. A signal transmission system as claimed in claim 1 in which transmissions are made using a single frequency for both directions of transmission, the said single frequency being the same for both the first and the second two-way communications link.

7. A signal transmission system as claimed in any of claims 1 to 6 in which the first communication link uses a different transmission technique from the second communications link.

8. A signal transmission system as claimed in any preceding claim in which at least one of the communications links utilise radio.

9. A signal transmission system as claimed in claim 7 in which one communications link utilises a digital cellular radio communication technique.

10. A signal transmission system as claimed in claim 7 in which one communications link utilises a digital cordless radio communication technique.

11. A signal transmission system as claimed in claim 7 in which one communications link utilises a digital cellular radio communication technique and the other communications link utilises a digital cordless radio communication technique.

12. A signal transmission system as claimed in any of claims 1 to 10 in which at least one of the communications links utilise light.

13. A signal transmission system as claimed in any of claims 1 to 10 or claim 12 in which at least one

of the communications links operates by guided transmissions.

14. A signal transmission system as claimed in any of claims 1 to 8 or claims 12 or 13 in which at least one of the communications links utilises a digital transmission system.

15. A signal transmission system as claimed in any preceding claim in which a single first station communicates with a plurality of second stations via a plurality of respective first communications links.

16. A signal transmission system as claimed in claim 15 in which each of the plurality of second stations communicates with a respective third station via a respective second communications link.

17. A signal transmission system as claimed in claim 15 or claim 16 in which at least one second station comprises means to send information to the first station as to whether or not the said second station is in communication with its respective third station, said first station comprising means to determine the number of said second stations with which it is capable of

communicating said means to determine taking said information into account when determining said number of said second stations.

18. A signal transmission system substantially as described with reference to the accompanying drawings.

19. Apparatus for use as a second station in a signal transmission system as claimed in any preceding claim, the apparatus comprising a single transmitter and a single receiver.

20. Apparatus for use as a second station in a signal transmission system as claimed in any of claims 1 to 18, the apparatus comprising a single transmitter and two receivers.

21. Apparatus for use as a second station in a signal transmission system as claimed in any of claims 1 to 18, the apparatus comprising a single receiver and two transmitters.

22. A mobile radio system in which a transmitter or receiver in a vehicle is arranged to communicate with a base station and a hand-portable unit using a

time-division multiplex procedure so as to avoid the need for duplication of the transmitter or receiver.

Published 1991 at The Patent Office. Concept House. Cardiff Road. Newport. Gwent NP9 1RH. Further copies may be obtained from Sales Branch. Unit 6. Nine Mile Point. Cwmfelinfach. Cross Keys. Newport. NP1 7HZ. Printed by Multiplex techniques ltd. St Mary Cray. Kent.

BNSDOCID: <GB___2241850A__I_>